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# 2009 CLEO Plenary Session - OPN Article Questions

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**OPN Article Questions for Edward I. Moses**
**2009 CLEO Plenary Session Keynote Speaker**

1. **Your plenary presentation at CLEO is titled "The National Ignition Facility: Exploring Matter Under Extreme Conditions." Can you give us a sneak peak of what you will discuss?**

The National Ignition Facility, or NIF, is the world's largest and highest-energy laser system. After a decade-long construction, NIF is essentially complete and ready to begin experiments leading up to ignition – achieving self-sustaining thermonuclear fusion and energy gain. I'll be discussing NIF's technical capabilities, the National Ignition Campaign – the multi-institutional program to achieve ignition – fusion energy and the exciting new scientific opportunities in astrophysics, material science, and other areas of high energy density science. Our plan is to make NIF a national users facility where time and resources will be made available to the broad scientific community. NIF has 192 giant lasers, housed in a ten-story building the size of three football fields, and it will deliver at least 80 times more energy than any previous laser system. NIF will be able to focus about two million joules of ultraviolet laser energy on a tiny target in the center of its target chamber. This will trigger a fusion reaction and create extreme conditions of temperature and pressure, conditions found in nature only in the cores of stars and giant planets. This fusion reaction will release many times more energy than the laser energy that was required to initiate the reaction, serving as a "proof-of-principle" for inertial confinement fusion. I'll also talk about the LIFE (Laser Inertial Fission-Fusion Energy) scheme, which is a fission-fusion hybrid power plant that can be used as a once-through, closed nuclear fuel cycle that could provide a sustainable, carbon-free source of energy, and has the potential to revolutionize our energy future.

2. **What are the main goals of NIF and what significance does it have to the laser science community?**

NIF was designed specifically to meet the needs of three mutually reinforcing missions: strategic security, fusion as a clean source of energy, and enabling important breakthroughs in high energy density science.

Not only is NIF the world's highest-energy laser – it will produce more than four megajoules of infrared laser energy – it's also the biggest optical instrument ever built. The facility has over 7,500 meter-sized optics and about 30,000 smaller optics. Constructing a laser facility of this size and complexity required the creation, in essence, of a whole new large-optics industrial capability. Fabricating the optics was just the beginning. NIF's optical specifications also required state-of-the-art measurement and coating techniques and new methods for amplifying the laser beams to the needed energy levels.

NIF scientists worked closely with major optics vendors such as Schott North America, Hoya Corp. USA, Cleveland Crystals, Kodak, ITT, Zygo Corp., Tinsley Laboratories, and Spectra-Physics, along with the University of Rochester's Laboratory for Laser Energetics, to develop these technologies. Our scientific and engineering team made order-of-magnitude improvements in manufacturing precision large optics, including continuous-pour glass, rapid-growth crystals, optical coatings and new finishing techniques that can withstand the ultra-high energy of the NIF lasers. By transferring NIF technologies and collaborating closely with vendors on new technology development, we've essentially reshaped the technology infrastructure and stimulated significant growth in the precision optics industry. NIF technology has supplied the seed for other large glass laser efforts in the United States, including the OMEGA laser at the University of Rochester and the Z-Beamlet laser at Sandia National Laboratory in New Mexico. Lasers in Japan, France, the UK, Germany and other countries around the world also use technology developed here. And NIF research into controlling optics damage from high-energy lasers is helping scientists plan for two major inertial confinement fusion projects now under development – the HiPER (European High Power Laser Energy Research) facility in the UK and FIREX (the Fast Ignition Realization Experiment) in Japan.

3. **NIF is on the cusp of achieving the world's largest and highest-energy laser, which researchers say will be a breakthrough in developing an infinite source of energy. What are the challenges and rewards of working on a project of that size and scope?**

It is incredibly exciting to build and plan experiments on the world's largest laser – experiments that could very well lead to the development of a clean, safe and virtually unlimited source of energy, with all the benefits to the human race that that implies. As I indicated, there have been a lot of challenges and a few setbacks along the way, but challenges are what make the work interesting. That is the nature of a grand challenge.

4. **The NIF is set for completion this year. After working on the project for several years, what are you looking forward to the most when the NIF is up and running?**

All 192 laser beams have been completed and fired into the target chamber—an accomplishment that gave me a tremendous sense of accomplishment and pride in the multidisciplinary team that made it possible. We expect to have most of our diagnostics in place this fall. Construction of NIF is an amazing accomplishment to be proud of, but what we're about to do with it will even be better. By the end of next year, we will have begun experiments leading to the realization of the long-sought goal of achieving controlled, self-sustaining nuclear fusion and energy gain. And even before then, experiments will be conducted that will help scientists from the United States and around the world explore the science of the universe in unprecedented ways. As I told our staff during a recent celebration of the installation of the final optical unit, we still have an incredible amount to do and an incredible amount to learn. It's all very exciting.

5. **Today it seems as though everyone is talking about developing new sources of clean energy. Can you tell us more about the Laser Inertial Fusion-Fission Energy (LIFE) project and how you see it changing the way the world meets its energy needs?**

As I mentioned earlier, LIFE is an exciting energy concept that has the potential to meet future worldwide energy needs in a safe, sustainable manner – without carbon dioxide emissions. What's more, by burning nuclear waste for its fuel, LIFE has the added benefit of shrinking the planet's spent nuclear fuel and other materials that lend themselves to nuclear proliferation. LIFE combines the best aspects of fusion and fission to provide a carbon-free, limitless source of carbon-free energy. Through the combination of fusion and fission, LIFE power plants could generate gigawatts of power for as long as 50 years without refueling, all the while avoiding carbon dioxide emissions, easing nuclear proliferation concerns and minimizing the concerns associated with nuclear safety and long-term nuclear waste. Existing and future inventories of spent nuclear fuel, natural and depleted uranium and weapons-grade plutonium could produce enough energy to meet the world's energy needs for thousands of years. And besides offering energy independence and security, LIFE power plants could provide an enormous economic competitiveness edge in the energy sector in the coming decade.

6. **Having been involved with laser sciences for more than 30 years, what do you think has been the greatest achievement in the field so far?**

It's hard to single out one "greatest achievement"; you would have to include such things as laser surgery and the many other medical uses, the industrial uses such as the precise cutting of materials, and of course, electronics – everything from supermarket scanners to compact disks. I believe that the field has developed to the point that, I believe this century will be known as the "photon century".

7. **With the 50th anniversary of the invention of the laser nearing, where do you see this pervasive technology going over the course of the next 50 years?**

It's amusing to think that when Charles Townes and Arthur Schawlow published their paper on the theory of the laser in 1958, many people called it a "solution in search of a problem." Now it's hard to think of an area of our lives that doesn't include the actual or potential use of lasers. In fact, I think the 21st Century is going to go down in history as "the photon century." Photonics is today where electronics was early in the last century. In addition to advances in laser surgery and broader medical uses, and industrial uses such as the precise cutting of materials, we envision using lasers to burn up nuclear waste and other hazardous materials, and to detect weapons-grade nuclear isotopes in shipping container. Lasers can be potentially used as defensive tactical lasers on the battlefield. For lasers and photonics, we're just at the beginning.

8. **Why did you pursue a career in laser sciences?**

I've been intrigued by lasers ever since I saw the first demonstration of one while I was studying electrical engineering in college and knew I would follow that beam. Even though I can't remember this myself, my mother tells me that my first word was "light."

9. **What's the best thing about being a physicist?**

I am certainly lucky enough to have my degrees in engineering but my training is in laser physics. I really think of myself as a systems person. The best thing about doing both physics and engineering is that you get to span the conception of ideas to building the technology that puts the theories of physics to the test – and if they hold up, to practical use.

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